

Methods and data processing report for ^{210}Pb , ^{210}Po and Ba survey during EXPORTSNP

Document authors and contact information

Montserrat Roca-Martí (mrocamarti@whoi.edu) and Ken Buesseler (kbuesseler@whoi.edu)
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Dataset authors

Ken Buesseler, Montserrat Roca-Martí, Tristan Horner, Pere Masqué

Brief protocol description and sample analysis

^{210}Po , ^{210}Pb survey

We used the $^{210}\text{Po}/^{210}\text{Pb}$ pair to quantify particle flux from the well-lit surface layer and its attenuation with depth in the upper twilight zone. Due to its half-life (138.4 days), ^{210}Po integrates a time scale of several months prior to the sampling. Export estimates from ^{210}Po will be compared to other methods with shorter time scales, ^{234}Th (weeks) and sediment traps (days), with the aim to provide more insights into the export and attenuation of sinking particle fluxes below the euphotic zone. The link from ^{210}Po to particulate organic carbon (POC) and other elemental fluxes (particulate nitrogen, particulate inorganic carbon, biogenic silica and phosphorus) is based upon determining the ratio of particulate ^{210}Po to the corresponding element measured on depth resolved profiles of size-fractionated particles (>1 to 50-100 μm range) collected using in-situ pumps (see EXPORTS_EXPORTSNP_size-fractionated_particles_in_situ_pumps_report.pdf).

Total ^{210}Po and ^{210}Pb activities were determined from ten-liter seawater samples ($n = 36$) following the Co-APDC co-precipitation technique (Fleer and Bacon, 1984) using ^{209}Po and stable Pb as chemical yield tracers. The samples were filtered through 0.2 μm pore-size membrane filters and stored until further processing at Universitat Autònoma de Barcelona. There, the filters were digested using concentrated HNO_3 . Lead and polonium were separated by auto-deposition of Po onto silver discs, i.e. plating (Flynn, 1968), which were then counted by alpha spectrometry. Solutions were re-plated and passed through an anion-exchange resin to ensure the complete elimination of Po from samples (Rigaud et al., 2013). Samples were plated again after six months for determination of ^{210}Pb via ^{210}Po ingrowth. ^{210}Po and ^{210}Pb activities at the time of sampling were calculated applying blank, ingrowth, decay and recovery corrections, as detailed by Rigaud et al. (2013). Each ^{210}Po and ^{210}Pb measurement includes an associated uncertainty that accounts for errors in counting, detector background and ^{209}Po activity.

Barium survey

The abundance and isotopic composition of barium - an emerging geochemical proxy for organic carbon oxidation – was measured in seawater and particulate samples collected using *in situ* pumps and sediment traps in the upper mesopelagic (≤ 500 m). Earlier work has shown that barite (BaSO_4) micro-crystals precipitate inside biogenic aggregates in association with heterotrophic bacterial production, reflecting remineralization of organic matter (e.g., Dehairs et al., 2008; Martinez-Ruiz et al., 2018). However, our knowledge about barite cycling in seawater is limited. We are primarily interested in quantifying the relationship between organic matter remineralization and barite precipitation (and the Ba-isotopic composition thereof) in the context of the quantitative rate information derived from radionuclide proxies ($^{234}\text{Th}/^{238}\text{U}$ and $^{210}\text{Po}/^{210}\text{Pb}$) and sediment traps.

Total Ba concentration and Ba-isotopic composition were determined from seawater following the (Ba, Ca) CO_3 co-precipitation as described in Horner et al. (2015) using a ^{135}Ba - ^{136}Ba double spike. Ba was purified from the sample matrix using two passes of ion-exchange chromatography. Analyses were performed using a ThermoFisher Neptune multi-collector ICP-MS situated at the WHOI Plasma Facility. 2 SD uncertainties are reported for barium concentration and Ba-isotopic measurements. Barium data accuracy was monitored via processing and analysis of international reference materials as part of each batch of samples. Extraneous Ba added during sample processing was monitored via processing and analyzing of sub-ng aliquots of an isotopic double spike (^{135}Ba - ^{136}Ba) through all sample purification procedures.

Parameters and units

Parameter	SeaBASS name	Units
Lead-210	conc Pb 210	dpm/L
Polonium-210	conc Po 210	dpm/L
Barium	conc Ba total	nmol/L
Ba-isotopic composition ($\delta^{138/134}\text{Ba}_{\text{NIST}}$)	Ba 138 134 d delta	per mil

Key analytical method references

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